Investigation on Optimal Mixing with Linkage Sets and Its Application

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Outline

1. Background Knowledge
2. Motivation
3. Investigation on Different Masks
4. Optimal Mixing with Mask Selection
5. Conclusion

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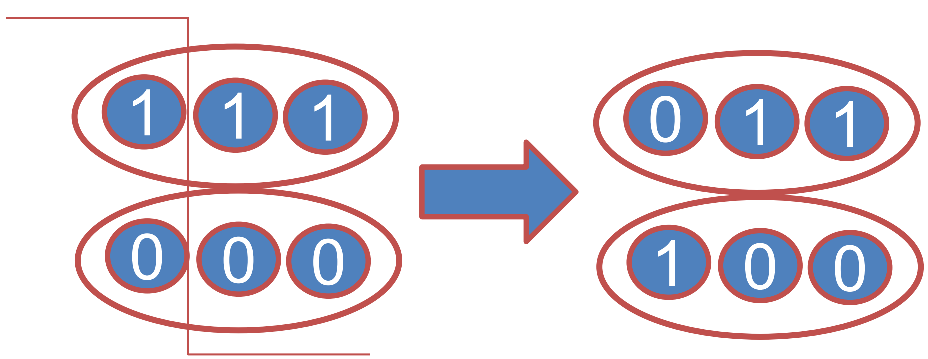
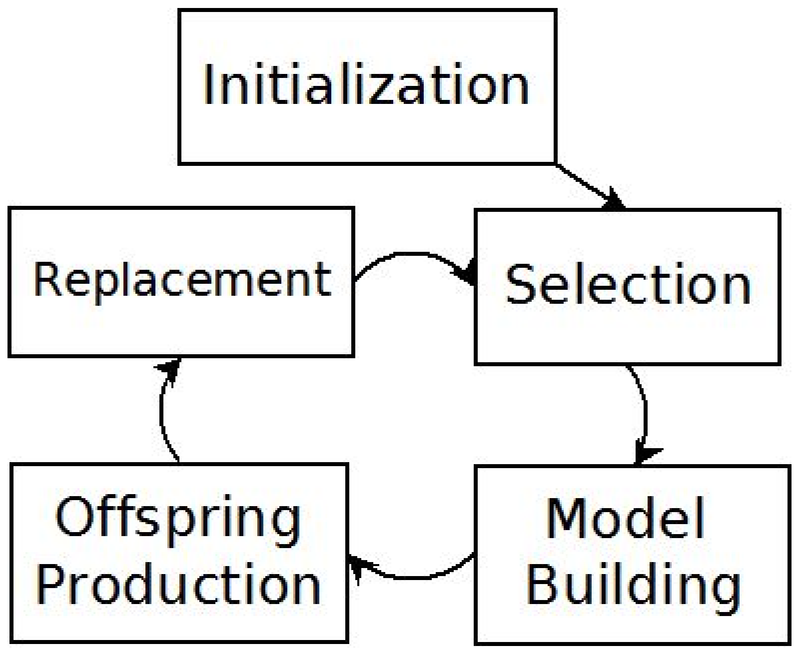
Simple GA ⇒ Model Building GA

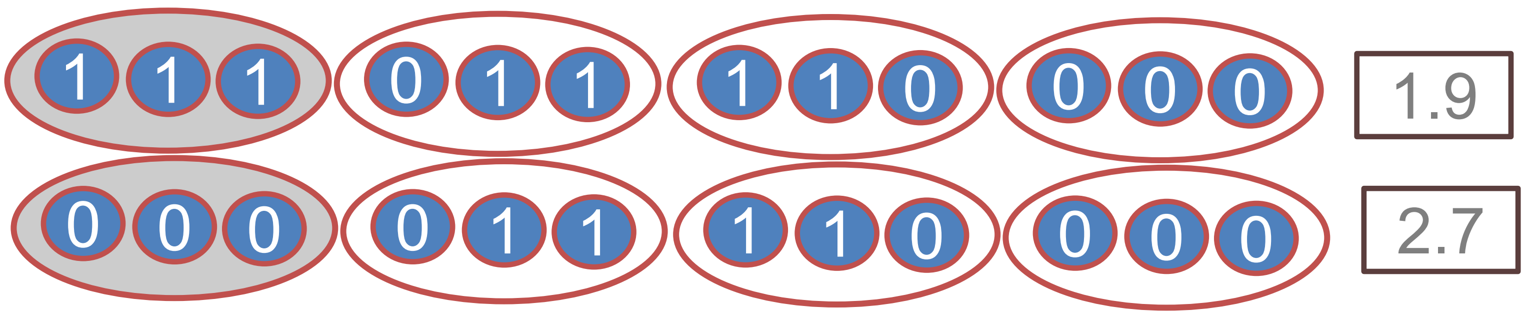
Schemata	fitness
000	0.9
001,010,100	0.45
011,101,110	0
111	1



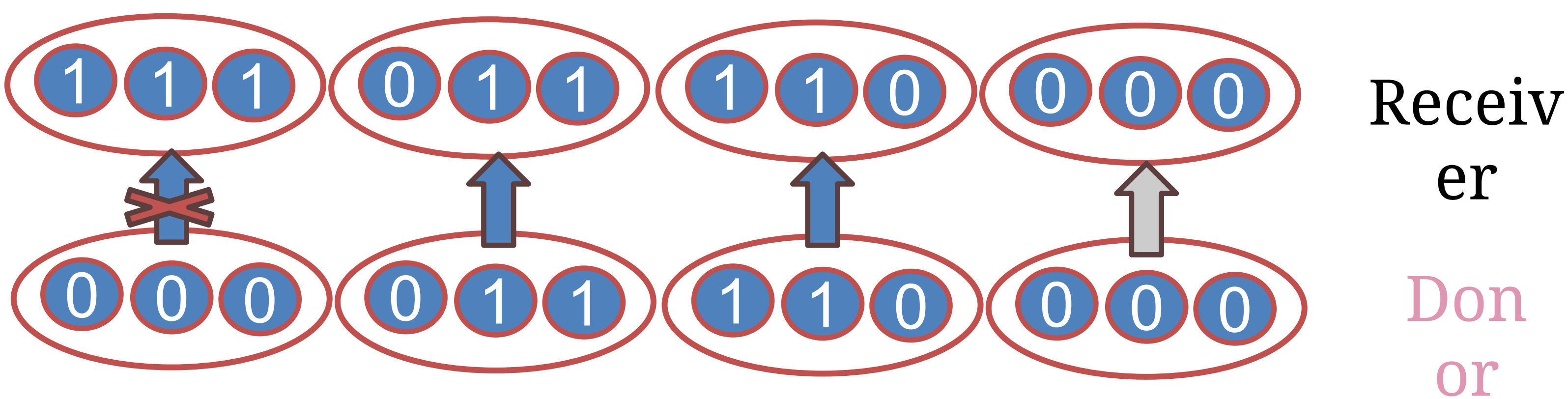


Optimal Mixing

- GA/MBGA : Large enough population ⇒ conquer sampling noise

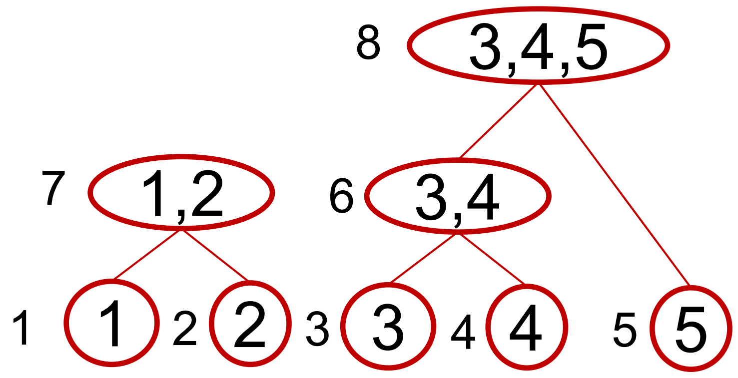


- Optimal Mixing : Donation and evaluation⇒ noise free



Linkage Tree (LT)

- Hierarchical Clustering
- Utilized (donation) in top-down order
- Robust since it is likely to cover all BBs



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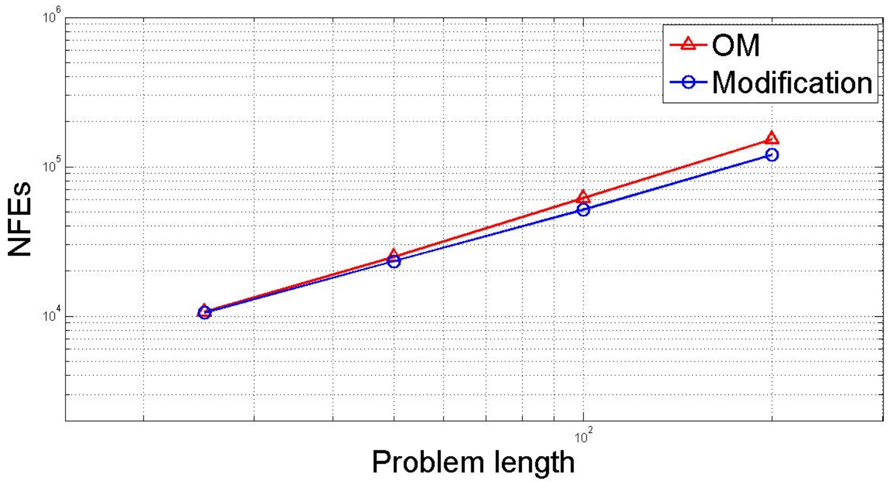
Motivational Experiment

- Small mask⇒ find local optima
- Large Mask⇒ recombine local optima
- An experiment on trap problem with k=5

  Two stage

  1^{st} generation : masks of size < 5

  Other generations : masks of size ≥ 5



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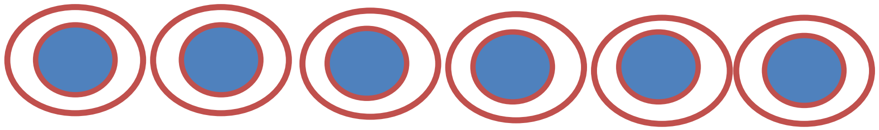
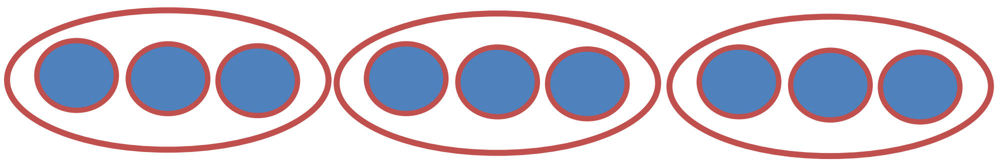
Problem Instances

- Homogeneous separable problem
- The one-max problem



- The (m, k)- trap problem



Linkage Set

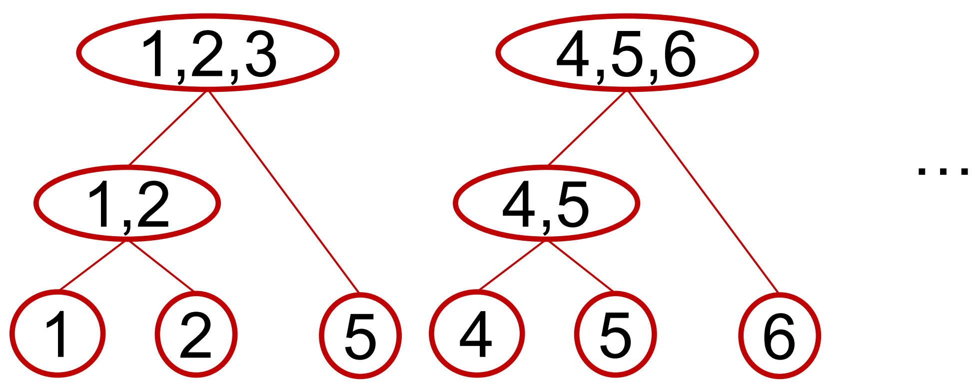
- Homogeneous and isomorphic set of masks

- Marginal product model (MP)

  $(\ell, 1)$-MP

  (m, k)-MP

- (m, k)- LT



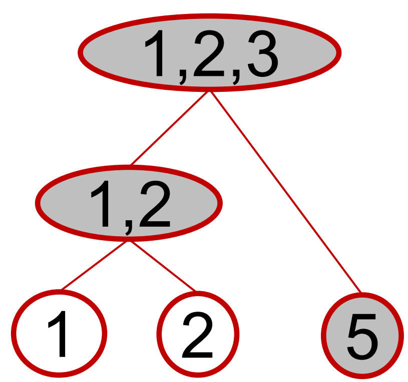
CP Index

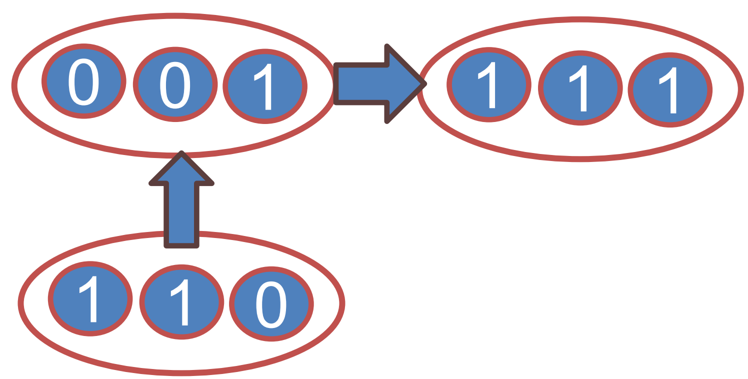
- $$CP_{theo}(\mathbb{M}, P) = \frac{E[\textsc{Gain}(S_{\mathbb{M},P}, S_{\mathbb{M},P}, \mathbb{M})]}{E[\textsc{Cost}(S_{\mathbb{M},P}, S_{\mathbb{M},P}, \mathbb{M})]}$$
- $S_{\mathbb{M},P}$: random variable of schemata
- Learn distribution of $S_{\mathbb{M},P}$ from population

$\textsc{Gain}(r, d, \mathbb{M}) = 3 - 1 = 2$

$\textsc{Cost}(r, d, \mathbb{M}) = 2$

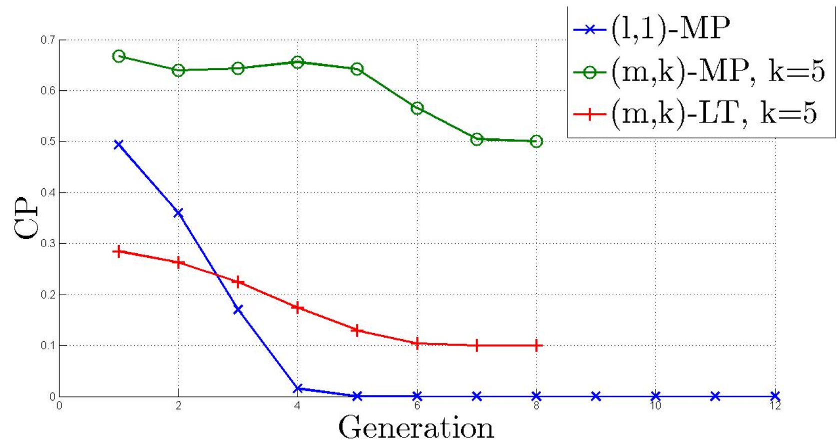
Schemata	fitness	rank
000	0.9	2
001,010,100	0.45	1
011,101,110	0	0
111	1	3

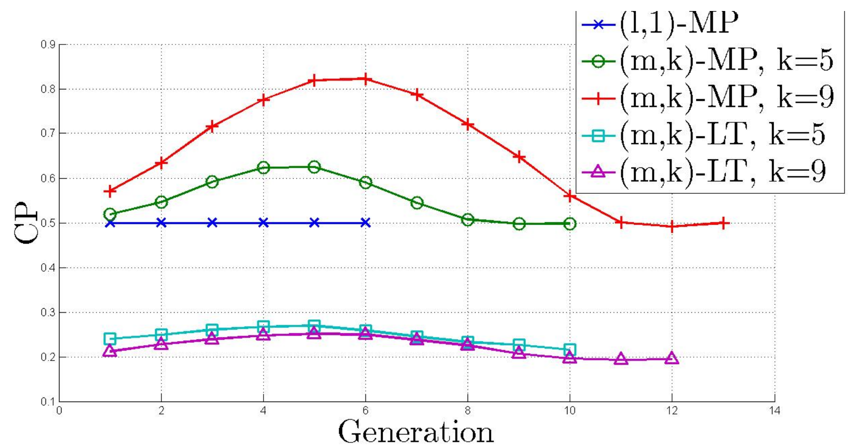




Model Efficiency

Model	Pop	NFEs
	316	***49982***
	264	129300
	Fail	Fail
	188	50013
	181	45889
	137	***39356***
	188	113440
	160	91393



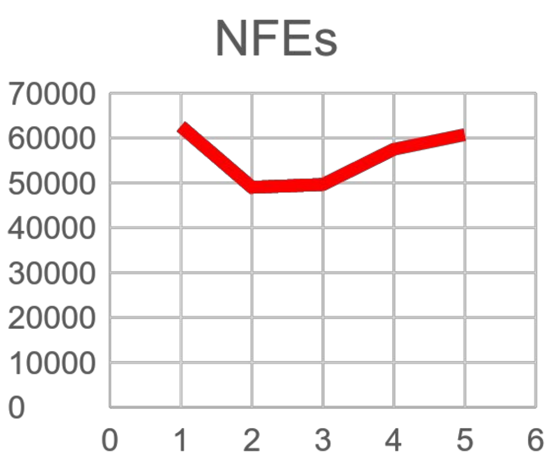


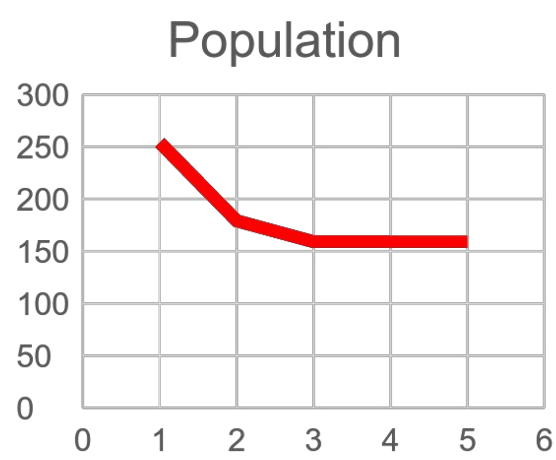
Population sizing

- Decision making⇒ noise-free decision making
- Model building⇒ rather robust hierarchal linkage tree
- Initial supply

Population sizing

- Perform OM+LT on the (m, k)-trap problem
- Discard masks of size $\mathbf{1}$ at different generation
- Small masks in early generations and large masks in late generations





Normalized CP

- $CP_{theo}(\mathbb{M}, P) = \dfrac{E[\textsc{Gain}(S_{\mathbb{M},P}, S_{\mathbb{M},P}, \mathbb{M})]}{E[\textsc{Cost}(S_{\mathbb{M},P}, S_{\mathbb{M},P}, \mathbb{M})]}$
- $CP_{prac}(M, P) = \dfrac{E[\textsc{Gain}(S^e_{M,P}, S^e_{M,P}, \{M\})]}{E[\textsc{Cost}(S^e_{M,P}, S^e_{M,P}, \{M\})]}$
- $CP_{norm}(M, P) = \dfrac{CP_{prac}(M, P)}{R(S^e_{M,P})H(S^e_{M,P})}$

- $S^e_{M,P}$: (random variable) schemata in population
- $R(S^e_{M,P})$: highest rank of
- $H(S^e_{M,P})$: entropy of $S^e_{M,P}$

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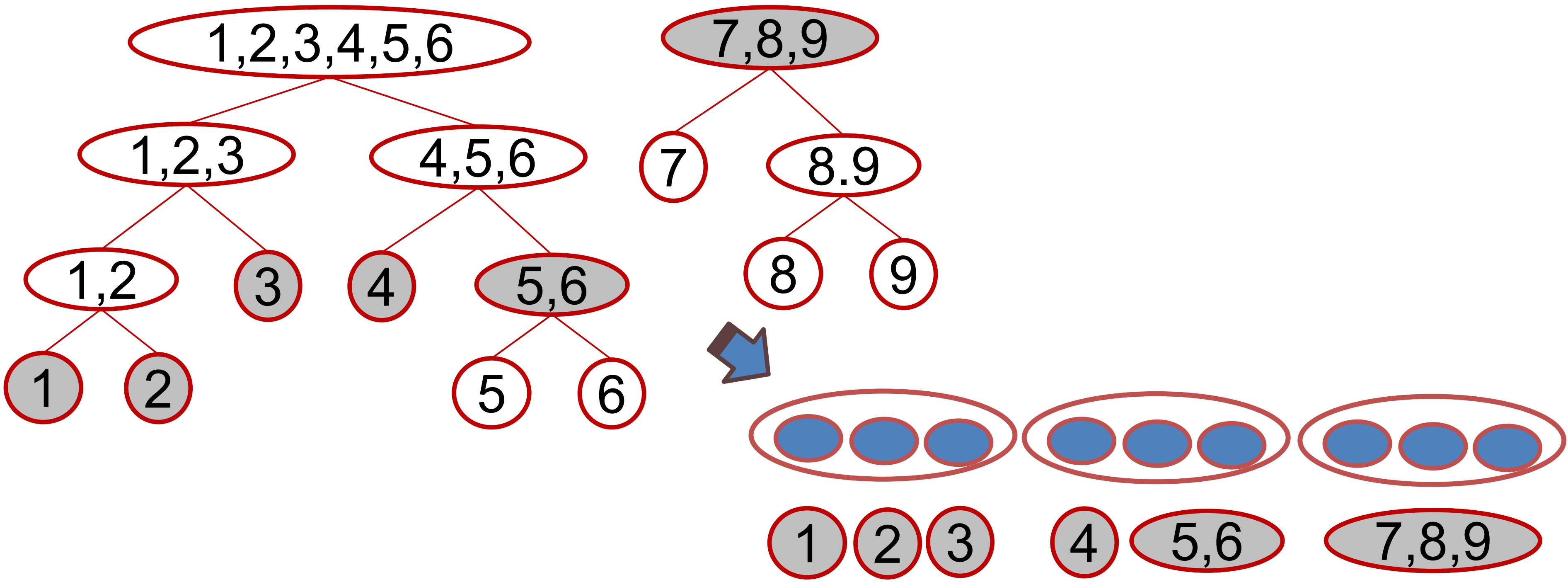
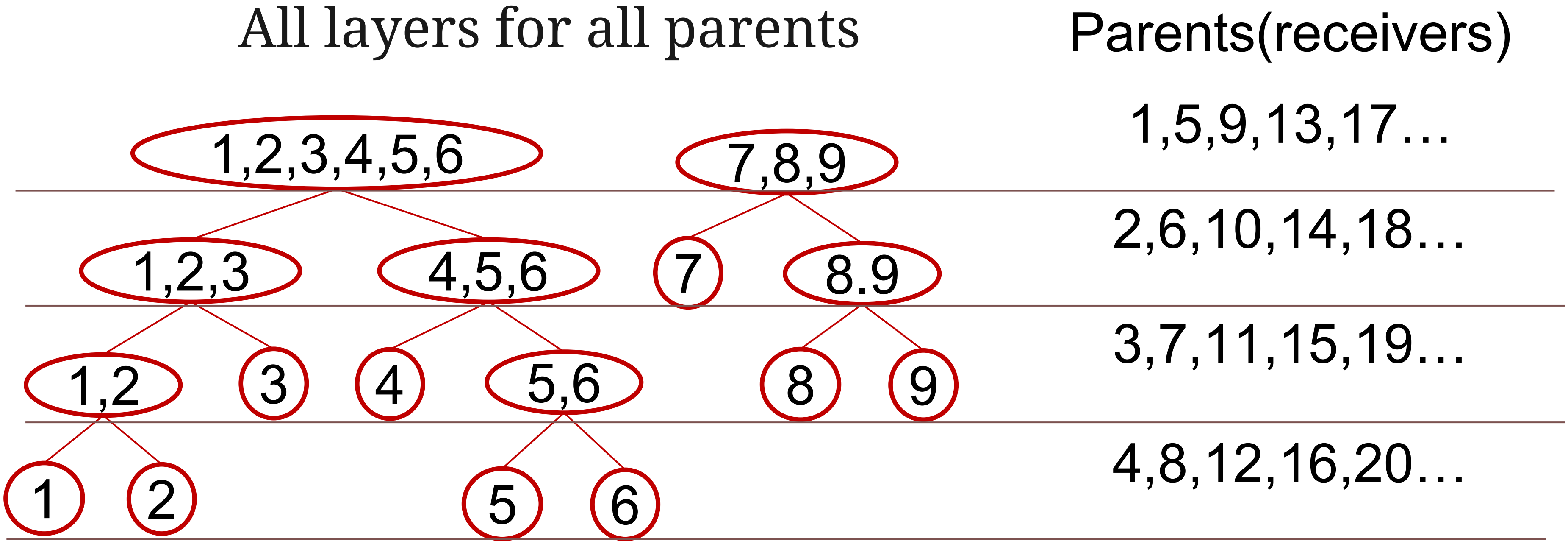
Modification of OM+LT

- Stage 1, OM+ 'some masks' : $P \Rightarrow O_{meta}$, CP_{norm} info
- $CP_{norm} \Rightarrow$ 'promising masks'
- Stage 2, OM + 'promising masks' : $O_{meta} \Rightarrow O$



CP Estimation

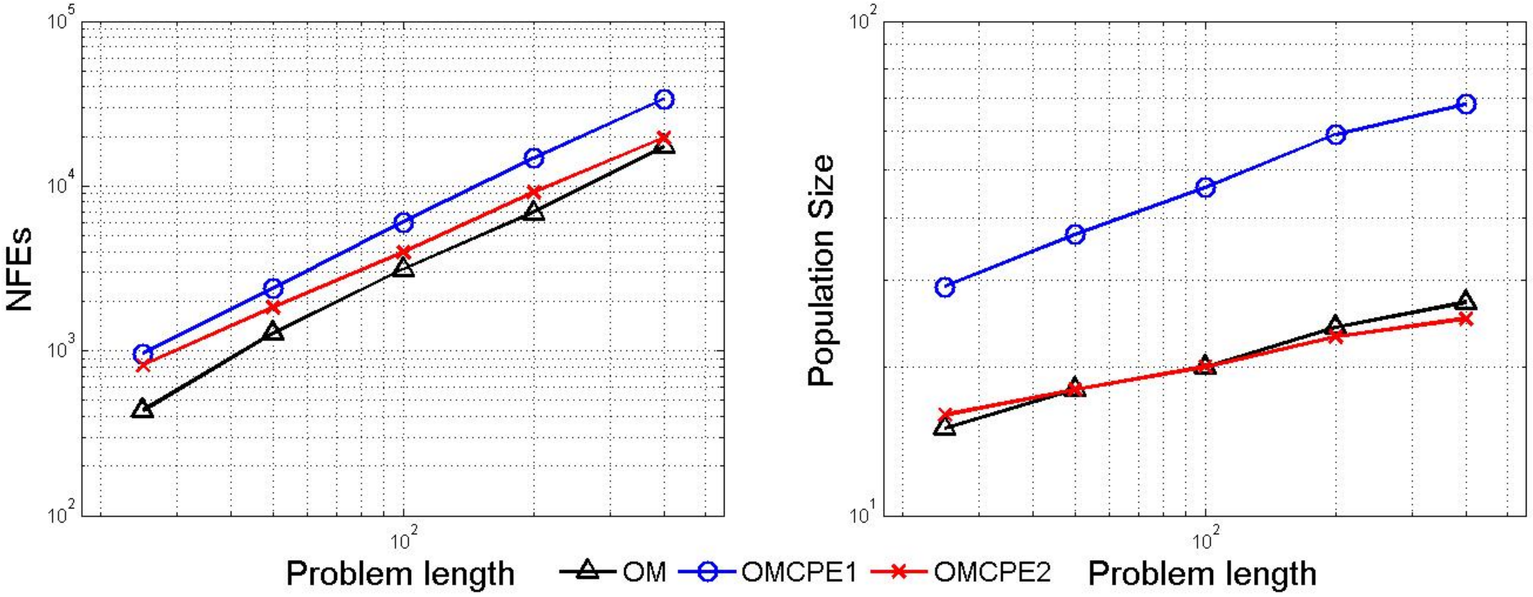
- Run OM one time, for each mask, CP= total gain/total cost
- Utilize (estimate CP) which masks for each receiver?
  - Different layers for different parents
  - All layers for all parents



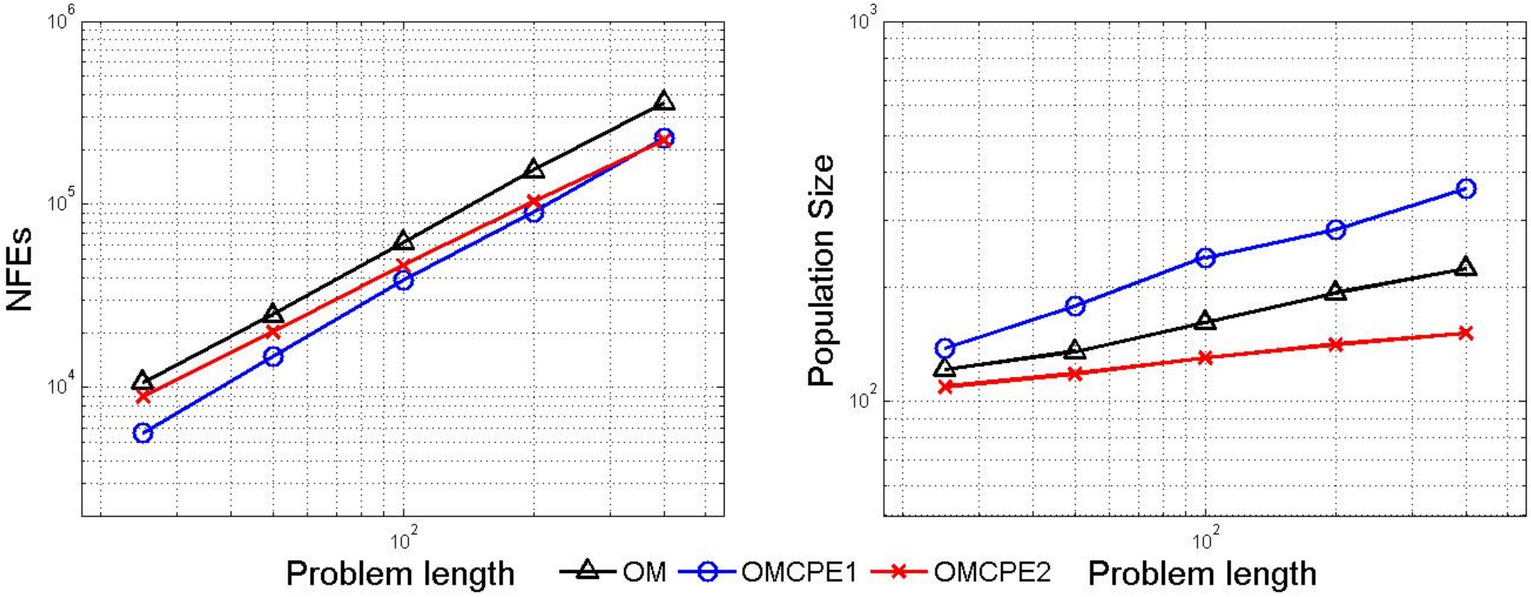
Experiment

- The one-max
- The trap problem
- The NK-landscape problem with no overlap
  general case of fully separable problem

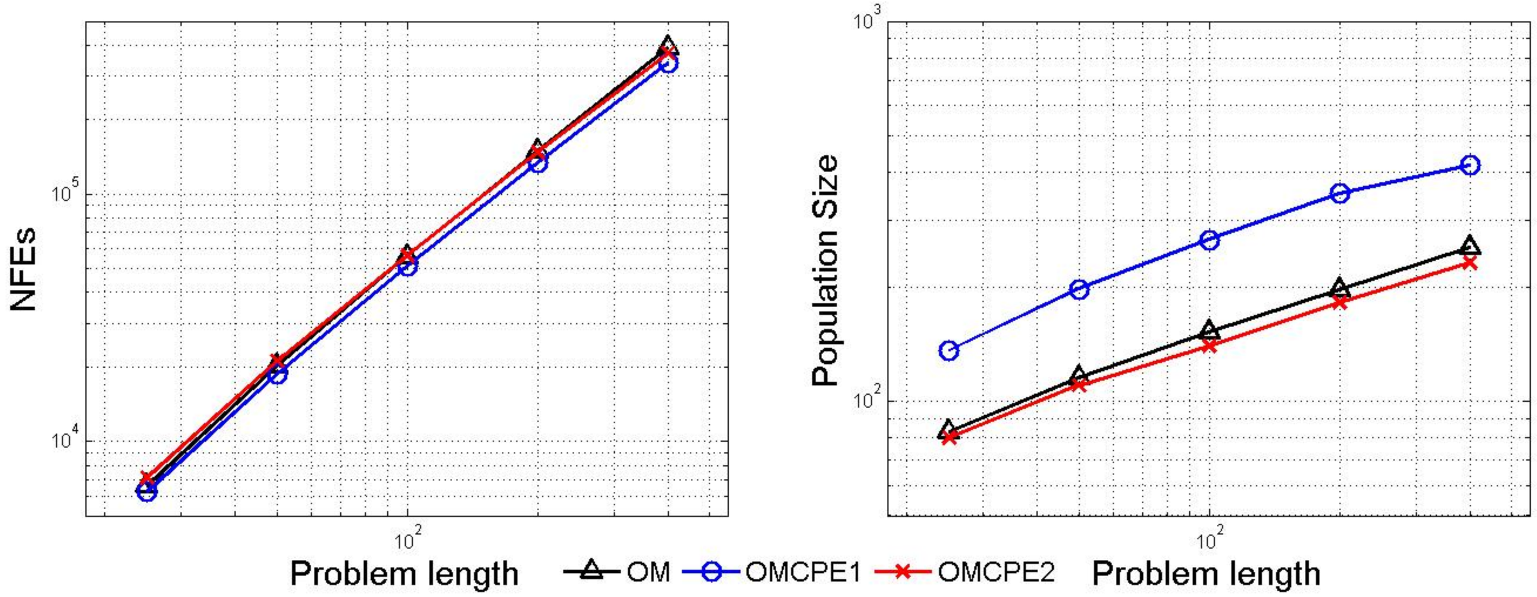
Experiment Results – One-Max



Experiment Results – Trap



Experiment Results –NK-landscape



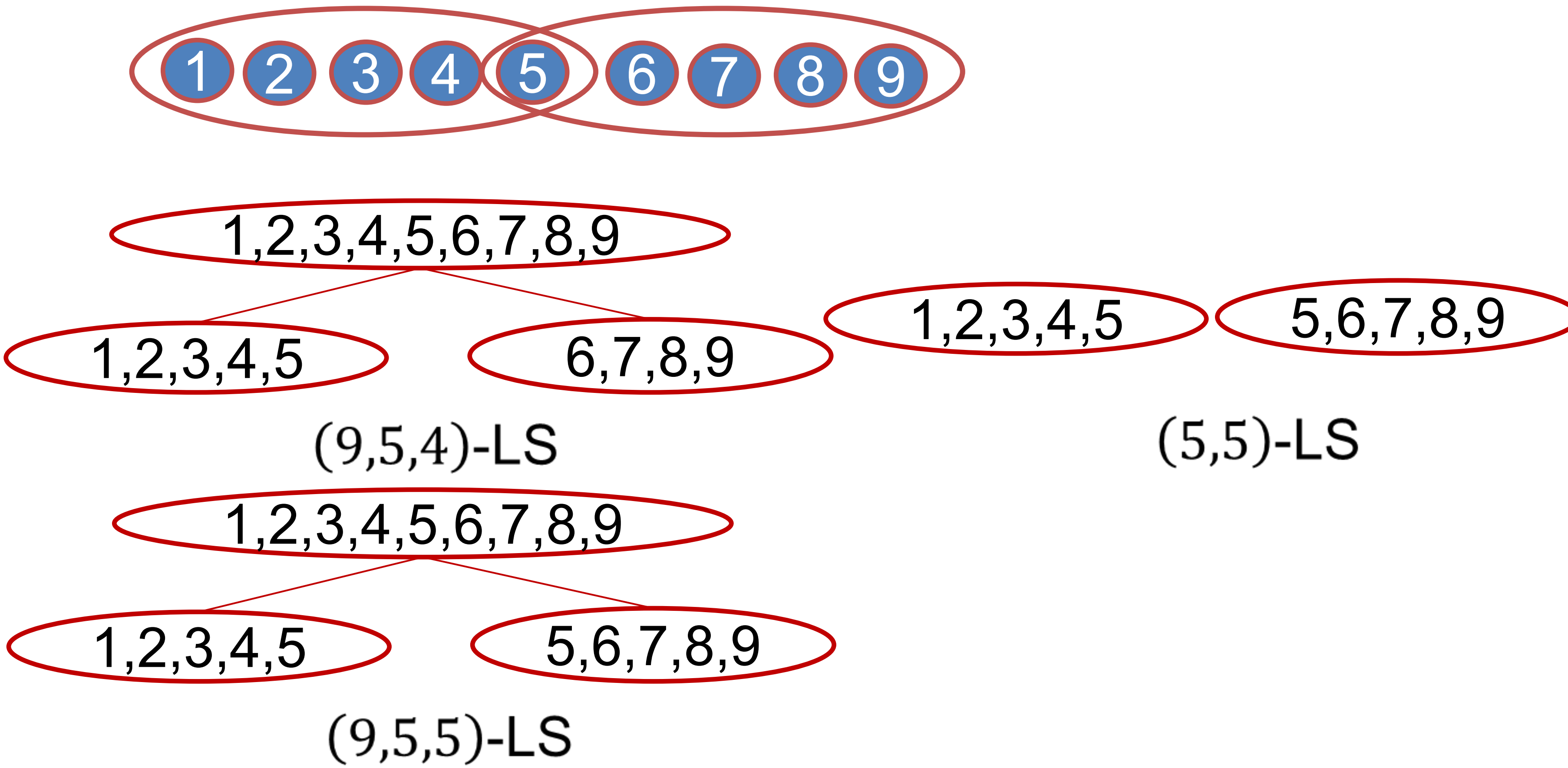
Summary & Conclusion

- OM is analyzed from the perspective of model efficiency and population sizing
- Mask pruning metric is designed
- OM-based algorithm with mask selection technique is designed
- Mask selection not only reduce NFEs but also make OM scale better
- This work can be extended to more complex scenario and help to improve OM

End

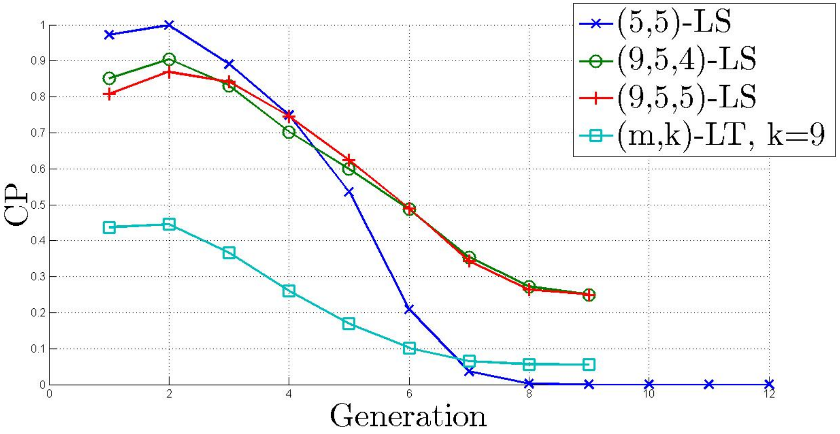
Overlap problem

- The aggregate trap problem

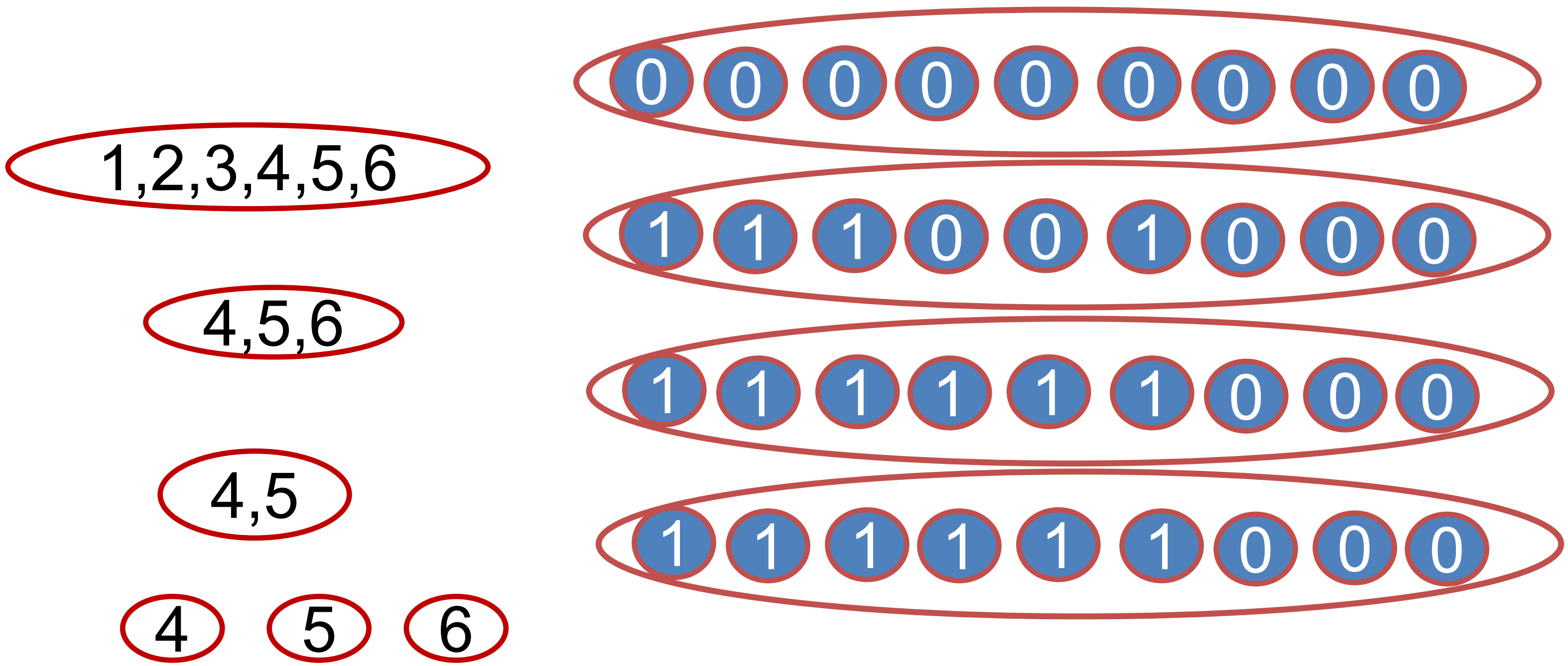


Overlap problem

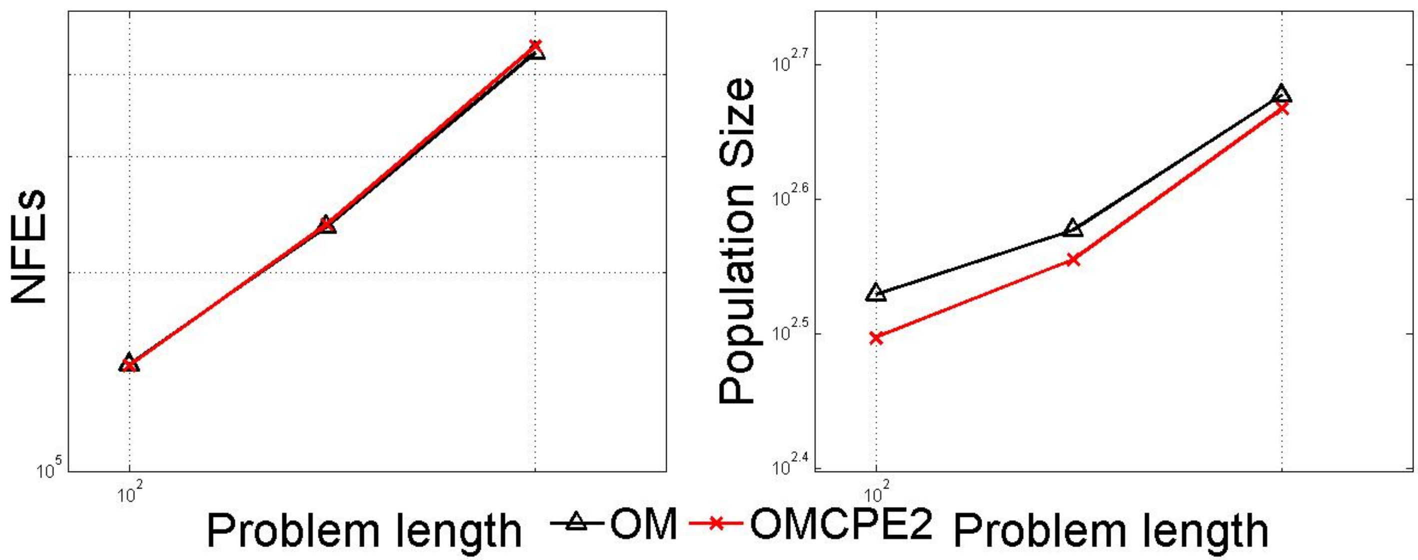
Fail	Fail
645	71433
620	68103
719	188352



Rank Estimation



Overlap NK-LandScape



Overlap NK-LandScape